D4

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 392 074 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89115993.1

(22) Date of filing: 30.08.89

(51) Int. Cl.5: **B23H 11/00, B23H 1/02**

(30) Priority: 13.04.89 JP 94242/89
13.04.89 JP 94243/89
13.04.89 JP 94244/89
13.04.89 JP 94245/89
13.04.89 JP 94246/89
13.04.89 JP 94247/89

(43) Date of publication of application:
17.10.90 Bulletin 90/42

(84) Designated Contracting States:
CH DE FR IT LI

(71) Applicant: SODICK CORPORATION
1-5-1 Shin-Yokohama Kohoku-ku
Yokohama, Kanagawa 222(JP)

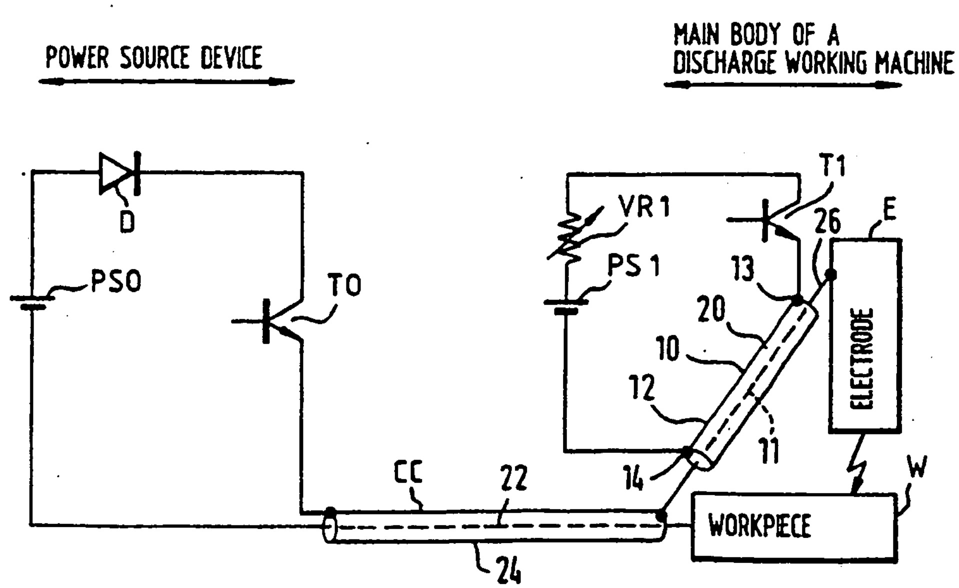
(72) Inventor: Nishimura, Hideo
2-13 Undookoen Mikunicho
Sakaigun Fukui(JP)

(74) Representative: Füchsle, Klaus, Dipl.-Ing. et al
Hoffmann . Eitle & Partner Patentanwälte
Arabellastrasse 4
D-8000 München 81(DE)

(54) Discharge working machine.

(57) A discharge working machine is disclosed in which a working current is supplied from a power source (PSO) to a working electrode (E) and a workpiece (W) by a core wire (11) of a coaxial cable (10) and a current flowing in the opposite direction to a current flowing through the core wire (11) flows into a shield (12) of the coaxial cable (10).

FIG.1



EP 0 392 074 A1

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to a discharge working machine which supplies a work current from a power source to a work electrode and a workpiece.

2. Description of the Prior Art

Figure 14 shows a schematic representation of a prior art discharge device. This discharge working machine is adapted to supply a discharge work current from a power source PSO through a diode D, a transistor TO and a coaxial cable CC to a work electrode E and a workpiece W.

A power supply device including the power source PSO, diode D, transistor TO and the like is connected to a main body of the discharge working machine including the work electrode E, workpiece W and the like by coaxial cable CC. Also, the coaxial cable CC is used to decrease an inductance between the power supply device and the discharge working machine main body to thereby enhance a working speed.

The above-mentioned conventional discharge working machine has, in the main body thereof, a portion in which the workpiece W and work electrode E are spaced from each other. Because the coaxial cable CC cannot be used in this portion, a single wire SW has been conventionally used as the connection in this portion. In particular, in an inter-polar portion which is interposed between the work electrode E and workpiece W, in fact, nothing but the single wire SW can be used.

However, a drawback exists in this structure that when a discharge work current flows through the single wire SW, an inductance is generated in the above-mentioned single wire SW. Because of the inductance, the rise time of the wave of the discharge work current is lengthened, and the peak value of the discharge current is made smaller. This deteriorates the working speed of the resultant system.

In order to increase the working speed, a power supply voltage must be increased, resulting in a larger consumption of electric power.

In addition, as the size of the whole discharge working machine is increased, the above-mentioned single wire SW must be made of a larger capacity, and is therefore enlarged. A larger wire can cause the working speed to be even further decreased. That is, according to the shapes and sizes of the discharge working machines, the performance thereof such as the working speed and the like varies, and cannot be expected to be constant.

Summary of the Invention

The present invention aims at eliminating the drawbacks found in the above-mentioned prior art apparatus.

Accordingly, it is an object of the invention to provide a discharge machine which is capable of increasing a working speed, of reducing the power consumption thereof for the same working speed, and of providing a constant working speed even when the characteristics of the discharge working machine are varied.

In order to attain the above object, the present invention proposes a discharge working machine in which a working current is supplied from a power source through a core wire of a coaxial cable to a working electrode and a workpiece, and a current opposite to the current flowing in the core wire is flowed in the shield of the coaxial cable to thereby increase a working speed. Also, according to the invention, for the same working speed, the power consumption thereof can be reduced and even if the discharge working machine is varied in characteristics, the working speed can be maintained constant.

BRIEF DESCRIPTION OF THE DRAWINGS

The exact nature of this invention, as well as other objects and advantages thereof, will be readily apparent from consideration of the following specification relating to the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof and wherein:

FIGURE 1 is a circuit diagram of an embodiment according to the invention;

FIGURE 2 is a circuit diagram of another embodiment according to the invention;

FIGURE 3 is an explanatory view used to illustrate the operation of the above-mentioned embodiments;

FIGURE 4 is a circuit diagram of a further embodiment according to the invention in which a current flowing in the shield of a coaxial cable is supplied from a power line;

FIGURE 5 is a circuit diagram of a still further embodiment according to the invention in which a current is supplied to the shield of the coaxial cable from a power source supplying a

working current;

FIGURE 6 is a circuit diagram of a modified version of the embodiment shown in FIGURE 5, with a transistor T2 being omitted therefrom;

FIGURE 7 is a circuit diagram of another embodiment according to the invention in which a current is flowed into the shield of the coaxial cable from a capacitor charged with surge energy;

FIGURE 8 is a circuit diagram of a modified version of the embodiment shown in FIGURE 7, with a variable resistor VR2 being omitted therefrom;

FIGURE 9 is a circuit diagram of still another embodiment according to the invention which uses two coaxial cables connected in parallel to each other, instead of a single wire SW according to the prior art;

FIGURE 10 is an enlarged view of the two coaxial cables shown in FIGURE 9;

FIGURE 11 is a circuit diagram of yet another embodiment according to the invention which uses three coaxial cables connected in parallel to one another, instead of the single wire SW according to the prior art;

FIGURE 12 is a circuit diagram of a further embodiment according to the invention in which a current is flowed into the shield of the coaxial cable only by means of induced voltage;

FIGURE 13 is a circuit diagram of a modified version of the embodiment shown in FIGURE 12, with a variable resistor 20 being omitted therefrom; and

FIGURE 14 is a circuit diagram of a discharge working machine according to the prior art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A detailed description will hereunder be given of the preferred embodiments of a discharge working machine according to the present invention with reference to the accompanying drawings.

Referring first to FIGURE 1, there is illustrated a circuit diagram of an embodiment of a discharge working machine constructed according to the invention.

In this embodiment, instead of a single wire SW which has been used in the prior art apparatus, there is provided a coaxial cable 10 which comprises a core wire 11, a shield 12 and an insulator 20 for insulating between the core wire 11 and shield 12. In order to produce the advantages of the present invention, the present invention uses structure in which a discharge working current flows through the core wire 11 and a current in the opposite direction to the discharge working current flowing through the shield 12.

The stray inductance caused in the cable by the current flow in one direction is therefore, at least partially, cancelled out by the opposite in direction current flow through the other part of the cable.

The core wire 22 of a coaxial cable CC is connected to a workpiece W, and the shield of the coaxial cable CC is connected to the core wire 11 of the coaxial cable 10 and to a working electrode E. Power source PS1 is provided separately from a power source PSO, and is connected in series to a variable resistor VR1, a transistor T1, and the shield 12 of the coaxial cable 10. The power source PS1 and transistor T1 are oriented such that a current from the power source PS1 is passed through transistor T1 to flow in the direction opposite to the direction of a working current flowing through the core wire 11.

The transistor T1 is adapted to turn on and off repeatedly in synchronization with the operation of a transistor T0.

In operation, the workpiece W is discharge worked by the repetitive turning on and off so that discharge pulses corresponding to the inter-polar state thereof, the material of the workpiece W, working speed, working liquid and the like are applied between the working electrode E and the workpiece W. The transistor T1 turns on and off repetitively with the same pulse width and at the same cycle with the repetitive on and off cycles of the transistor T0. An oscillator, or any other known controlling structure may be used for this purpose. The bases of the transistor can be commonly driven by this controlling structure.

The discharge starts when the transistor T0 is turned on. At this time the working current is allowed to flow toward the working electrode E from the coaxial cable CC. Since the transistor T1 is also on at this time, current is allowed to flow from the leading end 13 of the shield 12 of the coaxial cable 10 toward the trailing end 14 thereof. FIGURE 3 shows an equivalent circuit with the working current I flowing through the core wire 11 of the coaxial cable 10, being opposite in direction to the current i flowing through the shield 12.

Because of this steady state condition, the waveform of the working current I rises faster and is therefore made sharper as compared with that occurring in the prior art discharge working machine shown in FIGURE 14. This increases the peak value of the working current I, thereby enhancing the working speed. For a given working speed with the prior art discharge working machine shown in FIGURE 14, the voltage of the power source PSO can be reduced, to thereby decrease the power consumption.

As described above, the coaxial cable 10 is

used instead of the single wire SW, and currents which are opposite in direction to one another flow in central portion 11 and outer portion 12 respectively so that the peak value of the working current I can be increased. This can be achieved because the effective value of the inductance of the power line (coaxial cable 10) around the working electrode E can be decreased when compared with a value of inductance of the single wire SW used in the prior art discharge working machine.

Also, by adjusting the length L1 of the shield 12 in the axial direction thereof with respect to the length (which is designated by L2 in FIGURE 3) of the portion corresponding to the single wire SW used in the prior art, it is possible to adjust the value of inductance occurring in the portion (including the coaxial cable 10 and single wire 26 connected to the core wire 11) to be used in place of the prior art single wire SW. This adjustment allows the value of inductance obtained in a discharge working machine of a varying size to be adjusted to coincide with the value of inductance obtained in the substituting portion for the single wire SW in a discharge working machine of the greatest size. Because to this, even though different size discharge working machines are used, they can have the same working speeds.

Also, according to the prior art, the value of inductance in the portion of the single wire SW is reduced by increasing the number of the single wires SW. According to the above-mentioned embodiment of the invention, the values of inductance can be matched to each other without increasing the number of coaxial cables used.

FIGURE 2 shows a circuit diagram of another embodiment of a discharge working machine according to the invention.

The embodiment shown in FIGURE 2 is similar to that shown in FIGURE 1, but omits the variable resistor VR1 used in the first embodiment in FIGURE 1.

In conditions such as the peak value of the working current, the length of the coaxial cable 10 and the like are determined by setting the voltage of the power source PS1 at a given value, as shown in FIGURE 2, the variable resistor VR1 can be omitted. Alternatively, a fixed resistor may be used in place of the variable resistor VR1. Also, the transistor T1 can be omitted.

FIGURE 4 shows a circuit diagram of still another embodiment according to the invention in which the current to flow through the shield of the coaxial cable is supplied from the power line.

In this embodiment, instead of the single wire SW in the prior art, there is provided a coaxial cable 110 which comprises a core line 111, a shield 112 and an insulator 120 for insulating the core wire 111 and the shield 112 from each other. In this structure, a discharge working current flows through the core wire 111. The current of a power line L for supplying the working current to the working electrode E and workpiece W flows through the shield 112 in a direction opposite to the direction of the working current flowing through the core wire 111.

In other words, the shield 102 of the coaxial cable 110 is included as a part of the power line L extending from a power source PSO through a diode D to a transistor T0, and the direction of flow of the current in the power line L is set to be opposite to the direction of the working current flowing through the core line 111. Capacitor C1 is used to smooth a power voltage.

In this manner, as the discharge working is carried out, the current is allowed to flow through the power line L, the current is allowed to flow from the leading end 113 of the shield 112 of the coaxial cable 110 toward the trailing end 114 thereof, and the direction of the working current I flowing through the core wire 111 of the coaxial cable 110 is opposite to that of the current i flowing through the shield 112. This allows a steeper rise of the waveform of the working current I and a higher peak value of the working current I as compared with the prior art apparatus shown in FIGURE 14, to thereby enhance the working speed. Also, for a given speed of working operation as the prior art machine shown in FIGURE 14, the voltage of the power source PSO can be reduced to thereby lower the power consumption.

The embodiment illustrated in FIGURE 4 uses the current flowing through the power line L having passed through the shield 112 of the coaxial cable 110. This eliminates the need for any means for controlling the timing of the current flowing through the shield 112, which is further advantageous over the prior art apparatus.

Referring now to FIGURE 5, there is shown a circuit diagram of yet another embodiment according to the invention, in which a current is supplied to the shield of the coaxial cable from a power source, PSO which supplies a working current.

In this embodiment, instead of the single wire SW in the prior art, there is provided a coaxial cable 210 comprising a core wire 211, a shield 212 and an insulator for insulating the former two members from each other. A discharge working current flows through the core wire 211. Transistor T2 receives a current from a power source PSO to control the on and off cycles of the current to be flowed through the shield 212. The current through the shield 212 flows in the opposite direction to the current flowing through the core wire 211.

Here, a variable resistor VR2 is used to control the amount of the current flowing through the shield 212.

In other words, the current from the power source PSO is, under control of the transistor T2, passed through a diode D and the variable resistor VR2 and then flows into the shield 212 of the coaxial cable 210. The components of this embodiment are connected such that the direction of the current flowing into the shield 212 is opposite to the direction that of the current flowing through the core wire 211.

A transistor T0 is shown as an example of first switching means for controlling the on and off cycles of the working current flowing through the core wire 211. The transistor T2 is adapted to turn on and off repetitively in synchronization with the operation of the transistor T0 and shown as an example of second switching means for receiving the current from the power source PSO and for controlling the on and off cycles of the current to flow into the shield 211.

In this manner, the transistor T2 turns on and off with the same pulse width and at the same cycle as the repetitive on and off cycles of the transistor T0. When the transistor T0 turns on to start the discharge, the working current is allowed to flow from the coaxial cable CC toward the working electrode E. At that time, since the transistor T2 has turned on, the current is allowed to flow from the leading end 213 of the shield 212 of the coaxial cable 210 toward the trailing end 214 thereof. Therefore, the directions of the working current I flowing through the core wire 211 of the coaxial cable 210 and the current i flowing through the shield 212 of the coaxial cable 210 are opposite to each other.

In this case, when compared with the prior art apparatus shown in FIGURE 14, the waveform of the working current I rises more greatly (more sharply) and the peak value of the working current I is increased, thereby enhancing the working speed.

FIGURE 6 shows a circuit diagram of a modified version of the embodiment shown in FIGURE 5, in which the transistor T2 shown in FIGURE 5 is omitted.

FIGURE 6 shows another embodiment which forms a loop which is composed of a leading line extending from the cathode side of the diode D up to the shield 212, the shield 212, and finally a connection from the variable resistor VR2 to the earth side of the power source PSO. The current is supplied from the power source PSO, to a resistor, and the current flows into the shield.

In this structure, although the current always flows into the shield 212, at least while discharge is occurring between the electrode E and the workpiece W, inductance between the coaxial cable CC and the electrode E can be reduced. For this reason, the working speed can be improved.

It should be noted here that the variable resistor VR2 may be replaced by a fixed resistor.

Referring next to FIGURE 7, there is shown a circuit diagram of a further embodiment according to the invention in which current flows into a shield of a coaxial cable from a capacitor charged with surge energy.

In this embodiment, instead of the single wire SW according to the prior art apparatus, there is provided a coaxial cable 310 comprising a core wire 311, a shield 312 and an insulator for insulating the former two components from each other. A working current flows into the core wire 311, a transistor T0 is used to control the on and off cycles of the working current flowing through the core wire 311 and the surge energy that is generated in the transistor T0 is absorbed by a capacitor C2. The electric charges that are charged into the capacitor C2 are supplied to the shield 312 and controlled so that the current in the shield 312 flows in the opposite direction to the current flowing through the core wire 311.

In other words, the transistor T0 controls the on and off cycles of the working current flowing through the core wire 311, the capacitor C2 absorbs the surge energy generated in the transistor T0 and a transistor T3 controls the supply of the electric charges charged into the capacitor C2 to the shield 312, so that the direction of the current flowing into the shield 312 can be opposite to that of the current flowing through the core wire 311.

In this embodiment, diodes D1 and D2 are used to prevent inverse currents, respectively, and a variable resistor VR3 is used to control the amount of the current flowing into the shield 312. Also, the transistor T0 is shown as an example of first switching means which controls the on and off cycles of the working current flowing through the core wire. The capacitor C2 is a capacitor which is capable of absorbing the surge energy occurring in the first switching means, and the transistor T3 is an example of second switching means for controlling the supply of the electric charges into the capacitor C2 to the shield 312.

In this structure, the transistor T3 turns on and off repetitively with the same pulse width and at the same cycle with the repetitive on and off cycles of the transistor T0. Surge energy is generated when the transistor T0 turns on, the surge energy being absorbed by the capacitor C2. Immediately after the turn on of transistor T0, the transistor T3 turns on, so that the current stored from the surge energy is allowed to flow into the shield. The turn on of transistor T3 can be delayed by a capacitor or delay line, for instance, connected to its base. The value of the current can be controlled by adjusting the variable resistor VR3.

When transistor T0 turns on to thereby start the discharge, the working current flows from the

coaxial cable CC toward the working electrode E. At the same time since the transistor T3 turns on, the current is flowed from the leading end 313 of the shield 312 of the coaxial cable 310 toward the trailing end 314 thereof. This produces the current flow whereby as shown in FIGURE 3, the direction of the working current I flowing through the core wire 311 of the coaxial cable 310 is opposite to the direction of the current i flowing through the shield 312. In this case, when compared with the prior art apparatus shown in FIGURE 14, the rising of the waveform of the working current I is improved and the peak value of the working current I is greater, with the result that the working speed an be increased.

FIGURE 8 shows a circuit diagram of a modification of the embodiment shown in FIGURE 7, in which the variable resistor VR3 is omitted from the embodiment in FIGURE 7.

In order to increase the value of the current flowing into the shield 312, the value of the capacitor C2 may be increased and, in order to decrease the value of the current flowing into the shield 312, the value of the capacitor C2 may be decreased. Because of this, structure even if the variable resistor VR3 is omitted, the value of the current flowing into the shield 312 can be controlled to some extent.

This allows the inductance between the coaxial cable CC and the electrode E to be reduced, so that the working speed can be improved.

FIGURE 9 shows a circuit diagram of a still further embodiment according to the invention in which, instead of the single wire SW according to the prior art, two coaxial cables which are connected in parallel to each other are used.

FIGURE 10 shows an enlarged view of the two coaxial cables shown in FIGURE 9.

In this embodiment, the core wires 411 and 411a of first and second coaxial cables 410 and 410a are connected in parallel to each other, the shields 412 and 412a of the coaxial cables 410 and 410a are connected in series to each other. The two parallel-connected core wires 411 and 411a are used instead of the single wire SW used in the prior art. The leading end 413 of the shield 412 of the coaxial cable 410 is connected to the trailing end 414a of the shield 412a of the coaxial cable 410a by a lead wire 415, and the trailing end 414 of the shield 412 of the coaxial cable 410 is connected to the leading end 413a of the shield 412a of the coaxial cable 410a by a lead wire 415a.

The core wire of the coaxial cable CC is connected to the workpiece W, and the shield of the coaxial cable CC is connected to the working electrode E through the parallel-connected core wires 411, 411a of the coaxial cables 410, 410a.

When transistor T0 turns on and thus discharge is initiated, the working current is allowed to flow from the coaxial cable CC toward the working electrode E and this working current I is then allowed to flow through the core wires 411, 411a of the coaxial cables 410, 410a. Due to the working current I that flows through the core wire 411 of the coaxial cable 410, an induced voltage is generated in the shield 412 thereof, and, since the shield 412 cooperates with the lead wires 415, 415a and the shield 412a in forming a loop, the induced voltage allows an induced current i to flow. Also, the induced current i flows in the opposite direction to that of the working current I.

On the other hand, due to the working current I flowing through the core wire 411a of the coaxial cable 410a, another induced voltage is generated in the shield 412a. Since the shield 412a cooperates with the lead wires 415, 415a and the shield 412 in forming a loop, the induced voltage allows another induced current i to flow. Also, similarly to the above-mentioned case, the flowing direction of the induced current i is opposite to that of the working current I.

In this case, when compared with the prior art apparatus shown in FIGURE 14, the rising of the waveform of the working current I is improved (becomes sharper) and the peak value of the working current I is increased, so that the working speed can be enhanced.

FIGURE 11 shows a circuit diagram of another embodiment according to the invention which, instead of the single wire SW according to the prior art, uses three coaxial cables connected in parallel to one another.

In this embodiment, the trailing end 414 of a shield 412 of a coaxial cable 410 is connected to the leading end 43a of a shield 412a of a coaxial cable 410a by means of a lead wire 415a, the trailing end 414a of the shield 412a of the coaxial able 410a is connected to the leading end 413a of a shield 412b of a coaxial cable 410b by means of a lead wire 415b, nd the trailing end 414b of the shield 412b of the shield 412 of the coaxial cable 410 by means of a lead wire 415.

In this case, the core wire of the coaxial cable CC is connected to the workpiece W, and the shield of the coaxial cable is connected to the working electrode E by means of the core wires 411, 411a and 411b of the coaxial cables 410, 410a and 410b.

Although the two or three coaxial cables are employed in the above-mentioned embodiments of the invention, four or more coaxial cables can be used, provided that the core wires of the four or more coaxial cables are connected in parallel to one another and that the shields of the four or more coaxial cables are connected in series to one another.

Referring next to FIGURE 12, there is shown a circuit diagram of still another embodiment according to the invention in which a current flows into a shield of a coaxial cable only by means of an induced voltage.

In this embodiment, in place of the single wire SW used in the prior art apparatus, there is employed a core wire 511 of a coaxial cable 510, the leading end 513 of a shield 512 of the coaxial cable 510 is connected to the trailing end 514 thereof by means of a lead wire (a conductor) 521, and a variable resistor 520 is connected in series to the lead wire 521.

The variable resistor 520 is used to adjust the value of a current flowing through the shield 512. The lead wire 521 is only one example of one of many structures which can be used as the conductors.

Transistor T0 turns on to thereby start the initial discharge, causing a working current to flow from the coaxial cable CC toward the working electrode E. This working current I flows into the core wire 511 of the coaxial cable 510. At that time, due to the working current I flowing through the core wire 511 of the coaxial cable 510, an induced voltage is generated in the shield 512 thereof. Since the shield 512 cooperates with the lead 521 and variable resistor 520 in forming a loop, the induced voltage allows an induced current i to flow. Also, the direction of flow of the induced current i is opposite to that of the working current I.

According to this embodiment, when compared with the prior art apparatus shown in FIGURE 14, the rising of the waveform of the working current I is improved (becomes sharper) and the peak value of the working current I is increased, thereby enhancing the working speed.

Alternatively, in place of the variable resistor 520 used in the above embodiment, a fixed resistor may be used, or, the variable resistor 520 or fixed resistor may be omitted. As shown in FIGURE 13, the loop may be formed only by the shield 512 and lead wire 521.

Like in the circuit that is composed of the coaxial cable 10, another power source PS1, variable resistor VR1 and transistor T, or the circuit with part of the former circuit being omitted, the means used in place of the single wire SW in the prior art apparatus may be used the core wire of the coaxial cable CC and the workpiece W.

Also, instead of the above-mentioned transistors T0, T1, T2 and T3, any other switching elements may be employed.

Further, the portion that is connected to the core wire of the coaxial cable CC may be connected to the shield thereof and the portion connected to the shield of the coaxial cable CC may be connected to the core wire thereof.

Although in the above-mentioned embodiments the lead wires are connected to the end portions (leading and trailing ends) of the shields such as the shield 12, the lead wires can be connected to other portions thereof.

In addition, current may flow into the field of the coaxial cable by other means different from those disclosed in the above-mentioned embodiments.

While the preferred embodiment has described operation using a discharge working machine, of course many other devices may be used to practice the invention.

All such modifications are intended to be encompassed within the following claims.

Claims

1. A connection for a discharge working machine using a working current which is supplied from a power source, comprising a coaxial cable having a core wire, a shield, and an insulator for insulating between the core wire and shield, said coaxial cable having a current flowing in a first direction through said core and a current flowing in a second direction opposite to said first direction in said shield.

2. A connection as in claim 1, further comprising means for supplying power to said coaxial cable, connected such that power flows in a first direction through said core, and in a second direction opposite to said first direction through said shield.

3. A connection as in claim 2, wherein said power supplying means includes a single power supply, connected such that power flows in said first direction through said shield to a first point, and from said first point to said core to flow therethrough in said second direction.

4. A connection as in claim 2, wherein said power supplying means includes two separate power supplies.

5. A connection as in claim 4, wherein one of said two separate power supplies is a capacitor, charged by surge currents caused during switching.

6. A connection for a supply of power, comprising:
a coaxial cable, having a core, and a shield, insulated from each other; and
means for supplying power to said coaxial cable, connected such that said power flows in a first direction through said core, and in a second direction opposite to said first direction through said shield.

7. A connection as in claim 6, wherein said power supplying means includes a single power

supply, connected such that power flows in said first direction through said shield to a first point, and from said first point to said core to flow therethrough in said second direction.

8. A connection as in claim 6, wherein said power supplying means includes two separate power supplies.

9. A connection as in claim 8, wherein one of said two separate power supplies is a capacitor, charged by surge currents caused during switching.

10. A connection for a discharge working machine, comprising:
a first power source for supplying a working current;
a coaxial cable having a core wire, a shield and an insulator for insulating the core wire and shield from each other, and connected to said first power source such that current from said first power source flows through said core wire in a first direction; and
another power source, provided separately from said first power source, connected to produce a current flowing in the opposite direction to said first direction in said shield.

11. A connection for a discharge working machine as set forth in Claim 10, further comprising a resistor,connected in series to said another power source.

12. A connection for a discharge working machine as set forth in Claim 10, further comprising a switching element for synchronization with a current from said first power source, connected in series to said another power source.

13. A connection for a discharge working machine in which a working current is supplied from a power source to a working electrode and a workpiece comprising:
a coaxial cable, having a core and a shield, a current of said power source supplying said working current to said working electrode and said workpiece through said core, and said shield of said coaxial cable receiving a current flow in the opposite direction to the working current flowing through said core wire of said coaxial cable.

14. A connection for a discharge working machine in which a working current is supplied from a power source to a working electrode and a workpiece comprising:
a coaxial cable comprising a core wire, a shield and an insulator for insulating the core wire and the shield from each other;
first switching means, connected to said power source, for controlling on and off cycles of working current to flow through said core wire in a first direction; and
second switching means, responsive to a current from said power source, for controlling on and off cycles of a current to flow into said shield in a second direction opposite said first direction.

15. A connection for a discharge working machine in which a working current is supplied from a power source to a working electrode and a workpiece, comprising:
a coaxial cable comprising a core wire, a shield and an insulator for insulating the core wire and shield from each other;
switching means, responsive to a current from said power source, for controlling on and off cycles of working current to flow through said core wire in a first direction, operable responsive to a current from said power source, including a resistor for flowing a current into said shield, and for controlling a current to flow into said shield in the opposite direction to said current flowing through said core wire.

16. A discharge working machine in which a working current is supplied from a power source to a working electrode and a workpiece by a core wire of a coaxial cable comprising the core wire, a shield and an insulator for insulating the core wire and shield from each other, said discharge working machine comprising:
first switching means for controlling an on and off cycle of a working current to flow through said core wire in a first direction;
a capacitor for storing a surge energy generated in said first switching means; and
second switching and setting means, coupled to said capacitor, for controlling a supply of the electric charge stored in said capacitor to said shield, and setting a direction of current flowing through said shield to be an opposite direction to said first direction of the current flowing through said core wire.

17. A discharge working machine as set forth in Claim 16, further comprising a resistor connected in series to said second switching means.

18. A connection for a discharge working machine in which a working current is supplied from a power source to a working electrode and a workpiece comprising:
a coaxial cable assembly, including a plurality of coaxial cables each comprising a core wire, a shield and an insulator for insulating the core wire and shield from each other, the core wires of each of said plurality of coaxial cables being connected in parallel to one another, and the shields of said plurality of coaxial cables being connected in series to one another, said core wires connecting said working current from said power source to said working electrode and workpiece.

19. A connection as in claim 18 further comprising means for supplying said working current through said core wires in a first direction and for supplying another current through said series con-

nected shield in a second direction opposite to said first direction.

20. A connection for a discharge working machine in which a working current is supplied from a power source to a working electrode and a workpiece, comprising:
a coaxial cable assembly formed of first and second coaxial cables, each comprising a core wire, a shield and an insulator for insulating the core wire and shield from each other, the core wire of said first coaxial cable being connected in parallel to the core wire of said second coaxial cable, a leading end of the sheild of said first coaxial cable being connected to a trailing end of the shield of said second coaxial cable, and a trailing end of the shield of said first coaxial cable being connected to a leading end of the shield of said second coaxial cable.

21. A connection for a discharge working machine in which a working current is supplied from a power source to a working electrode and a workpiece, comprising:
a coaxial cable comprising a core wire, a shield and an insulator for insulating the core wire and shield from each other, a portion of said shield being connected to another portion of said shield by means of a lead wire, wherein said shield and said lead wire are used to form a loop.

22. A connection as in claim 21, further comprising means for supplying power to said coaxial cable, connected such that power flows in a first direction through said core, and in a second direction opposite to said first direction through said shield.

23. A connection for a discharge working machine as set forth in Claim 21, further comprising a resistor in said loop.

24. A discharge working machine, comprising:
a working electrode;
a power supply means for supplying working current to said working electrode; and
a coaxial cable having a core wire, a shield, and an insulator for insulating between the core wire and shield, said coaxial cable connected to said power supply means to have a current flowing in a first direction through said core and a current flowing in a second direction opposite to said first direction in said shield.

FIG.1

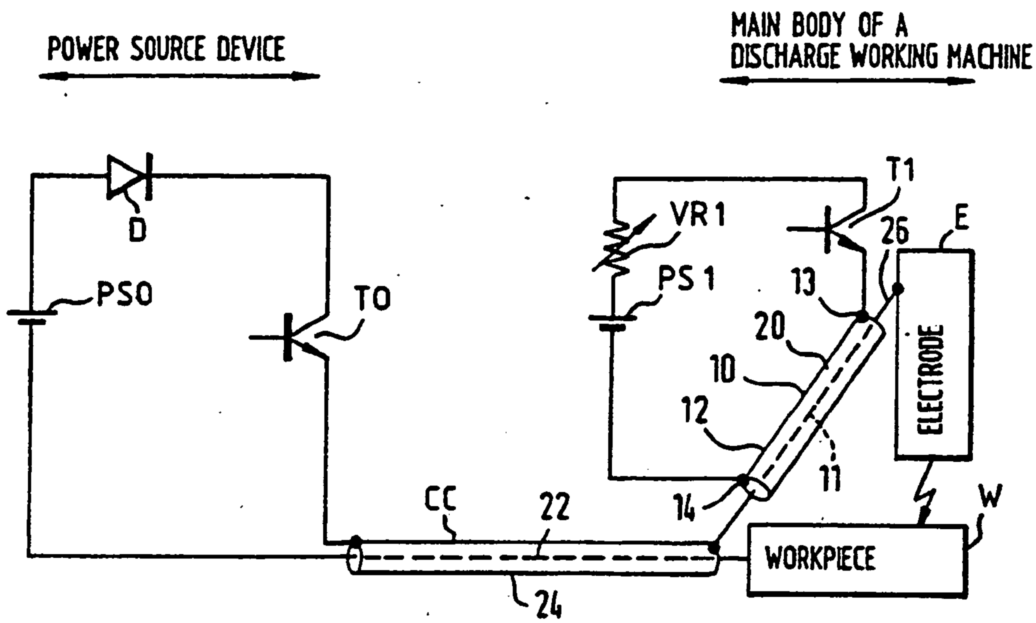

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
PS0
T0
VR1
PS1
T1
26
E
13
20
10
12
11
14
ELECTRODE
CC
22
24
W
WORKPIECE

FIG.2

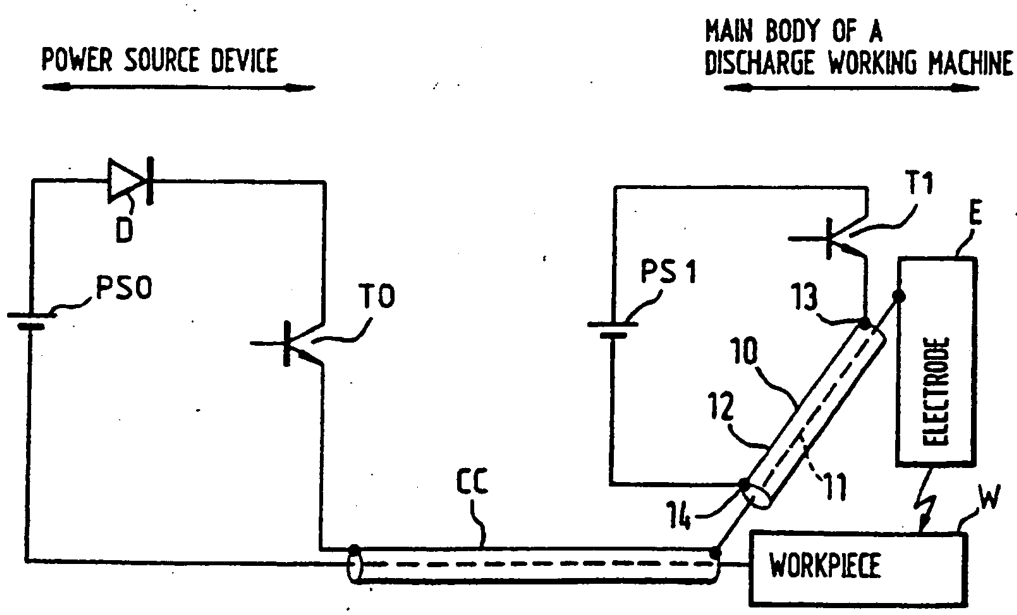

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
PS0
T0
PS1
T1
E
13
10
12
11
14
ELECTRODE
CC
W
WORKPIECE

FIG.3

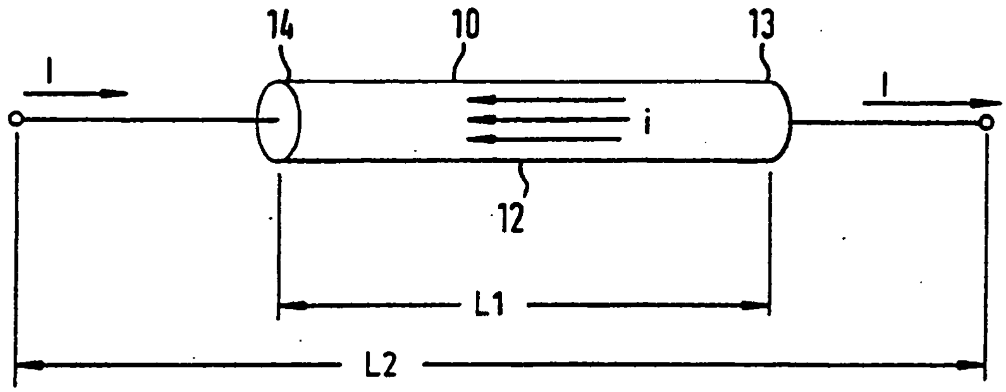

14
10
13
I
I
i
12
L1
L2

FIG.4

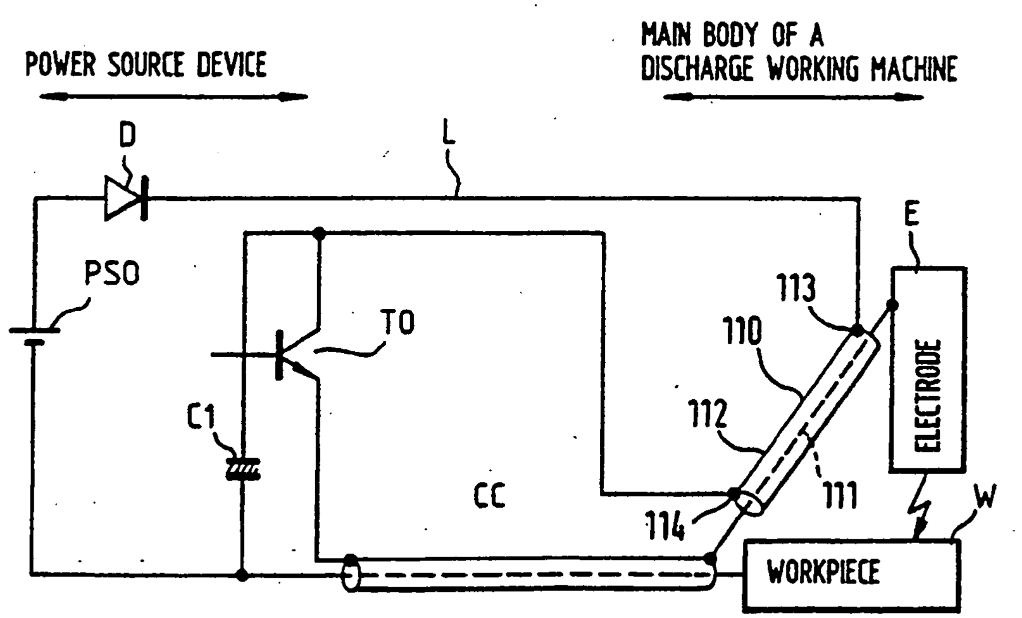

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
L
E
PSO
113
TO
110
ELECTRODE
C1
112
CC
111
114
W
WORKPIECE

FIG.5

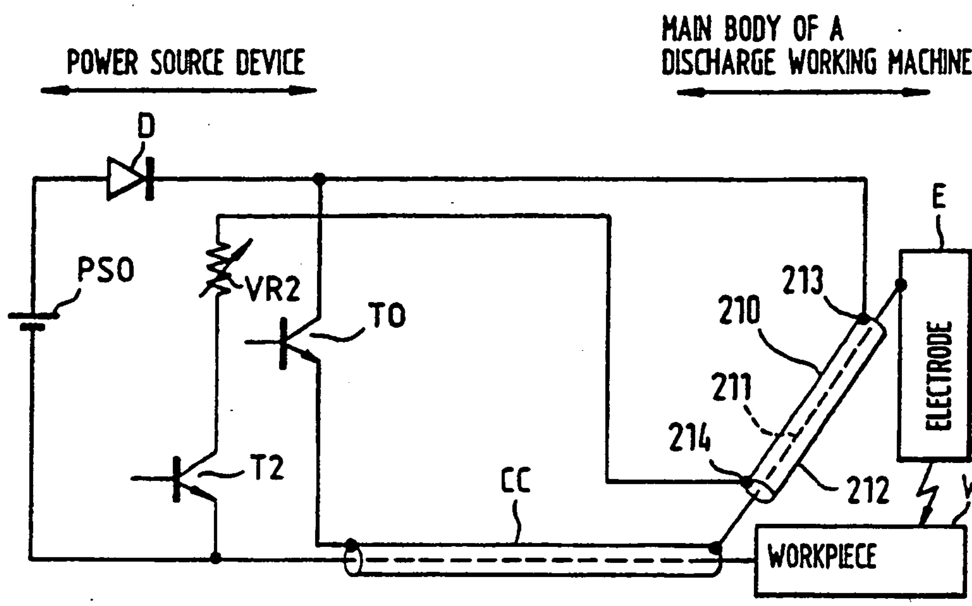

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
PSO
VR2
TO
T2
CC
E
ELECTRODE
213
210
211
214
212
W
WORKPIECE

FIG.6

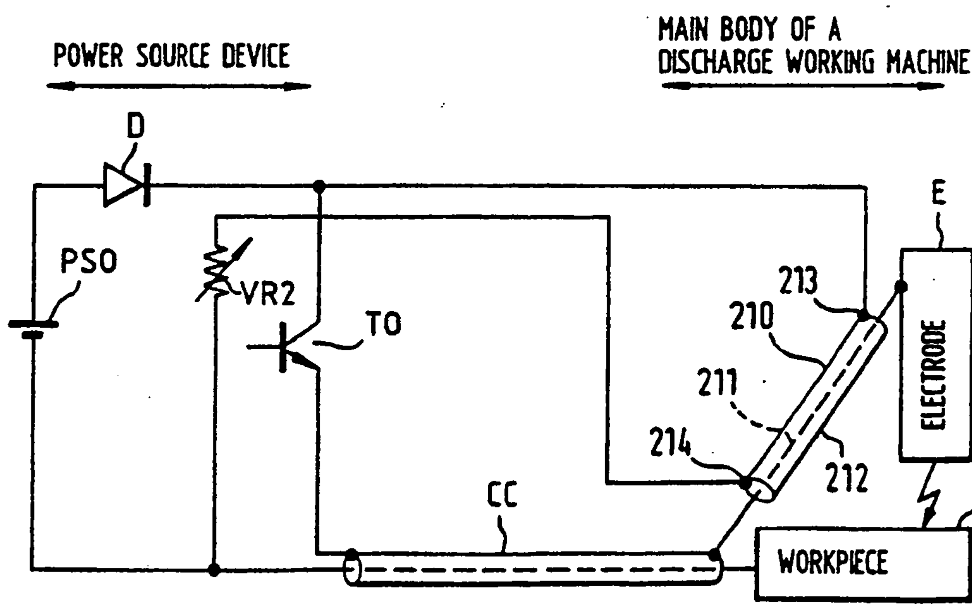

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
PSO
VR2
TO
CC
E
ELECTRODE
213
210
211
214
212
W
WORKPIECE

FIG.7

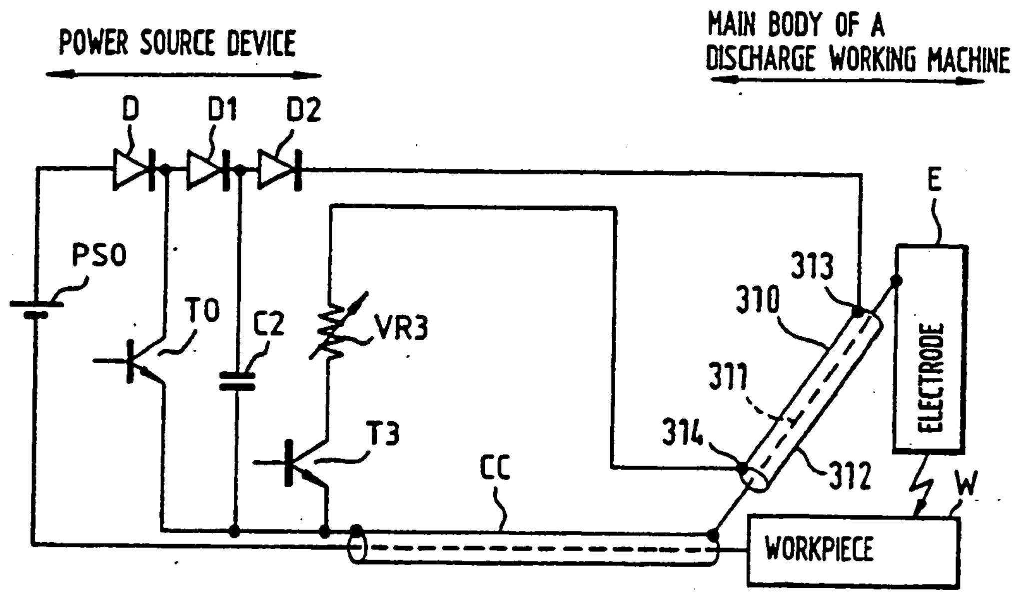

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
D1
D2
E
PS0
T0
C2
VR3
313
310
311
314
T3
CC
312
W
ELECTRODE
WORKPIECE

FIG.8

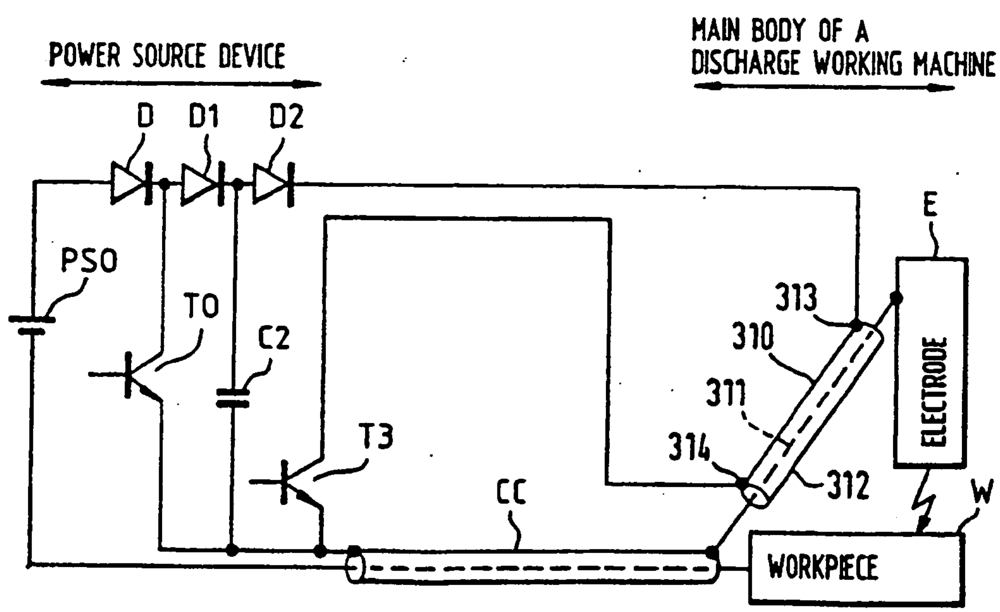

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
D1
D2
E
PS0
T0
C2
313
310
311
T3
314
CC
312
W
ELECTRODE
WORKPIECE

FIG.9

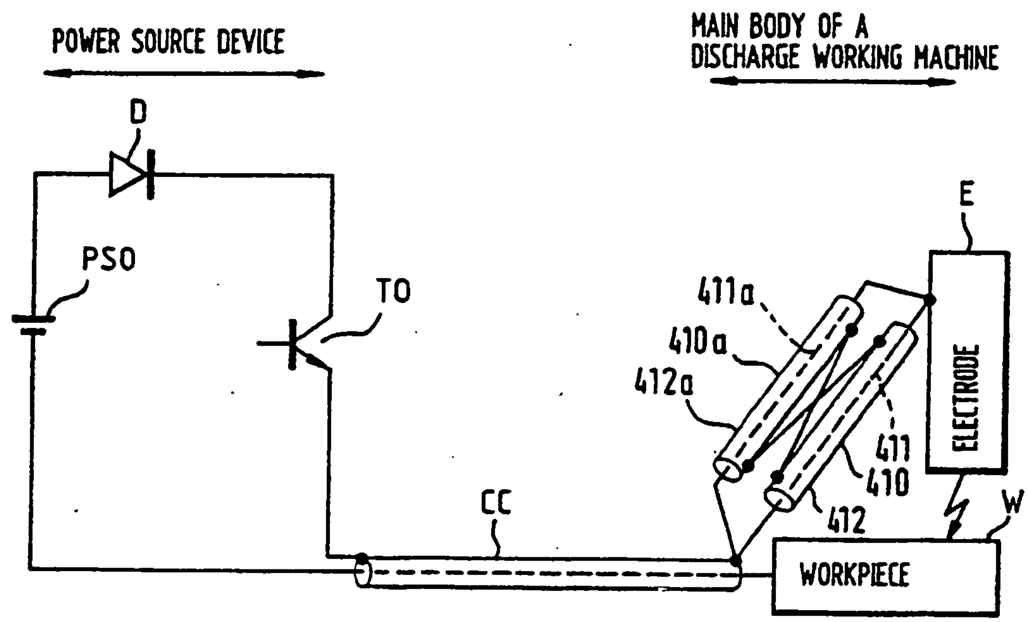

POWER SOURCE DEVICE
MAIN BODY OF A DISCHARGE WORKING MACHINE
D
PSO
TO
E
411a
410a
412a
411
410
412
ELECTRODE
CC
W
WORKPIECE

FIG.10

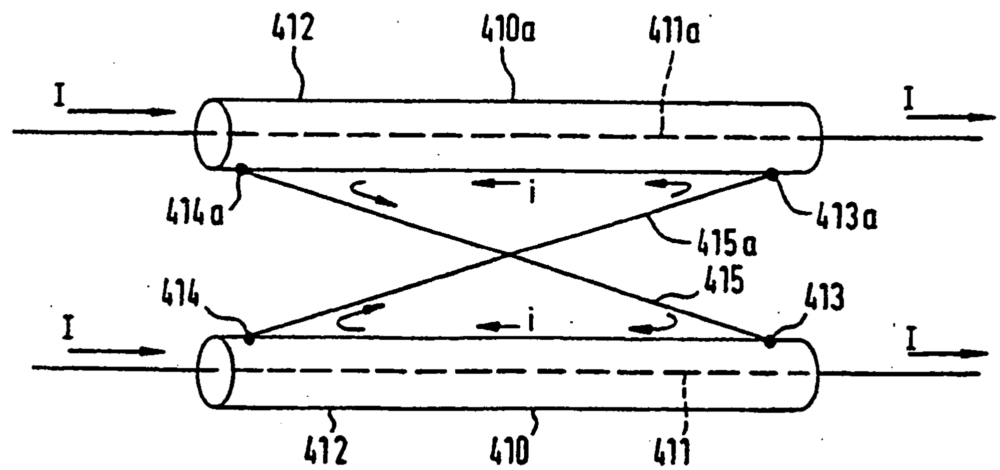

412
410a
411a
I
I
i
414a
413a
415a
415
414
413
I
i
I
412
410
411

FIG.11

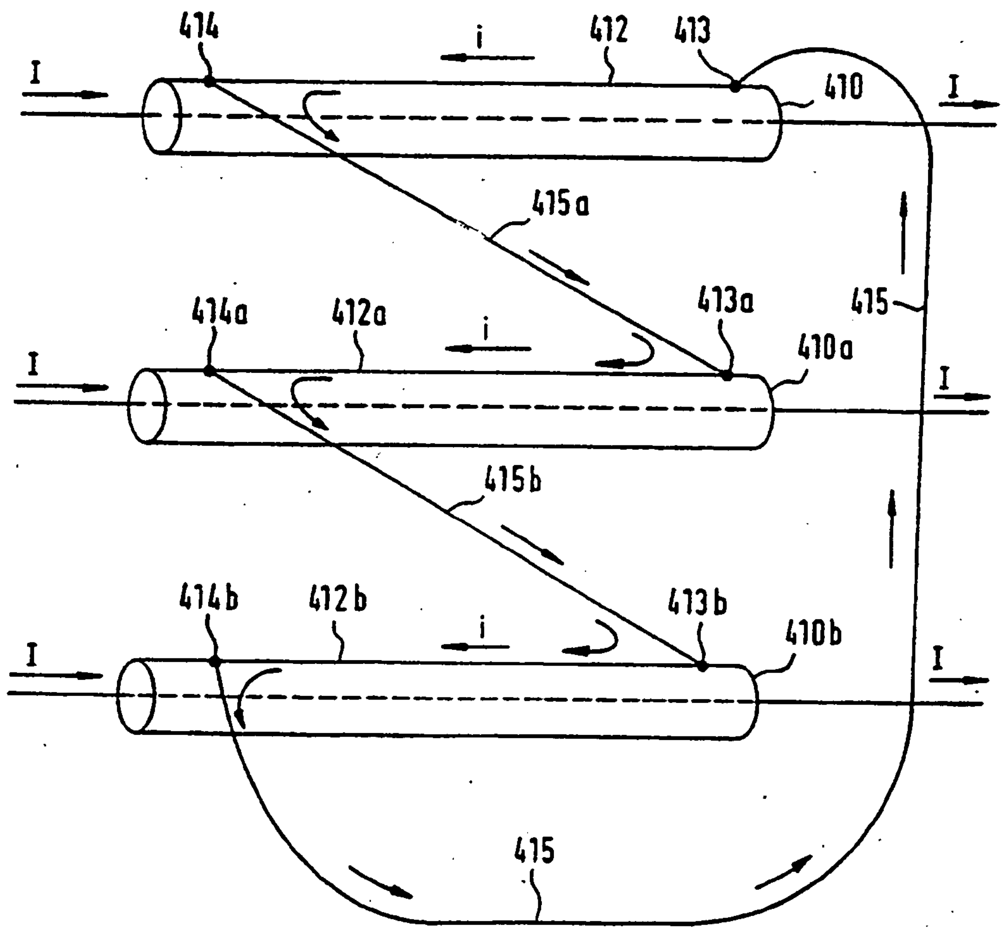

414
i
412
413
I
410
I
415a
415
414a
412a
413a
410a
i
I
I
415b
414b
412b
413b
410b
i
I
I
415

FIG.12

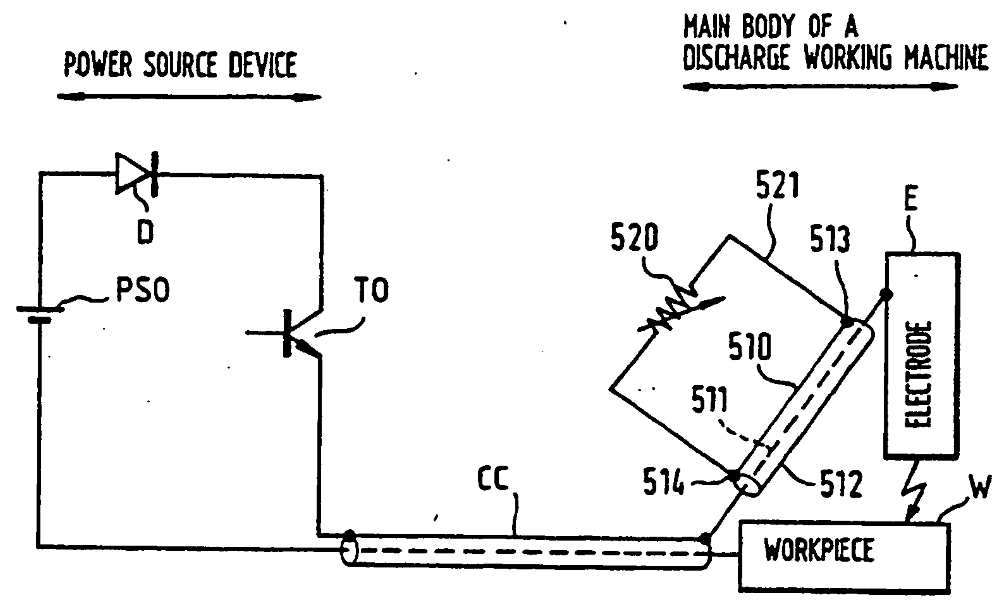

POWER SOURCE DEVICE
MAIN BODY OF A
DISCHARGE WORKING MACHINE
D
PSO
TO
520
521
513
E
510
511
ELECTRODE
CC
514
512
W
WORKPIECE

FIG.13

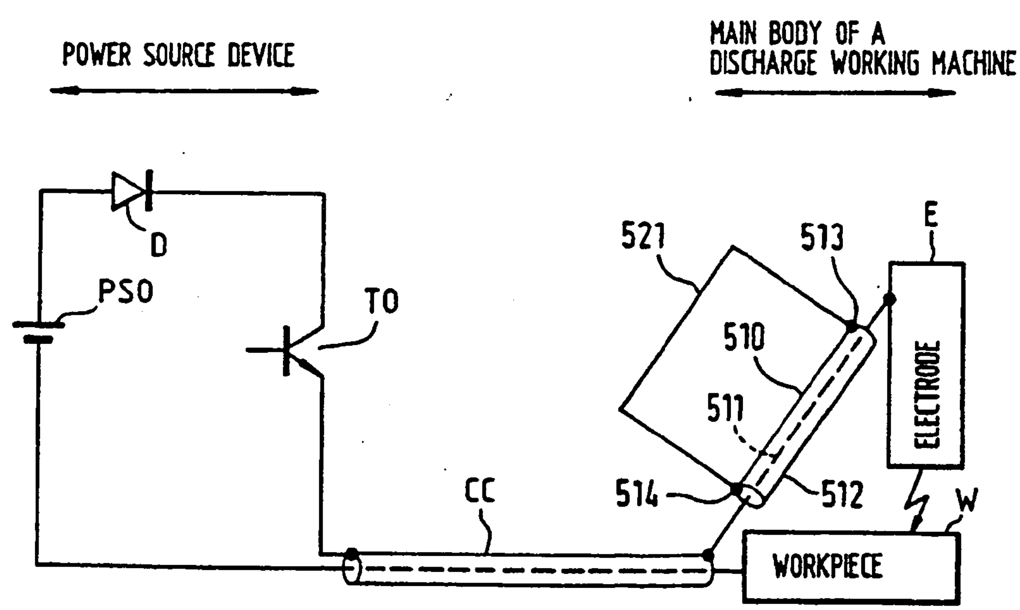
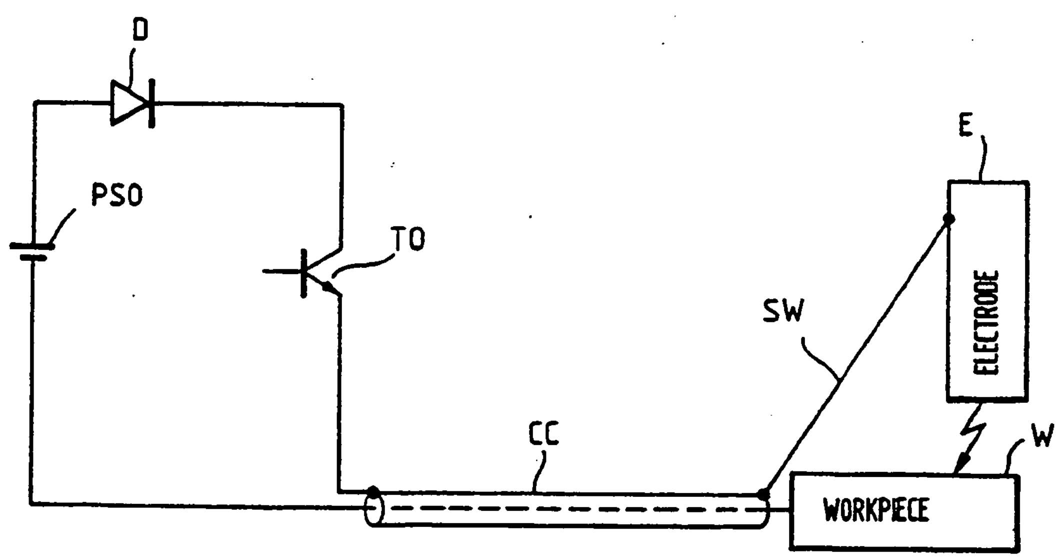

POWER SOURCE DEVICE
MAIN BODY OF A
DISCHARGE WORKING MACHINE
D
PSO
TO
521
513
E
510
511
ELECTRODE
CC
514
512
W
WORKPIECE

FIG.14
PRIOR ART



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 11 5993

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 11, no. 57 (M-564)(2504) 21 February 1987, & JP-A-61 219518 (AMADA CO) 29 September 1986, * the whole document *	1, 2, 6, 13, 24	B23H11/00 B23H1/02
A	EP-A-137751 (INOUE JAPAX) * page 3, line 16 - page 4, line 12 *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B23H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08 JUNE 1990	DAILLOUX C.

1

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document